Thermal conductivity of two kinds of earthen building materials

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1. Introduction – Earthen building materials have been used in all antique civilizations (Greek, Roman, Egyptian, Aztec, etc.). [1] Undamaged earthworks of these civilizations still exist nowadays. [2] Earthen buildings are known as passive solar buildings, i.e. naturally airconditioned. This is due to the low thermal conductivity of their construction materials. Traditional building materials based on earth offer the following advantages: easily accessible, inexpensive and above all environmentally friendly. They are manufactured by hand, but their manufacturing techniques vary from region to region even in the same country.

Image 1. Earthen buildings

Unfortunately, these natural materials are almost out of service in Algeria, despite their assets. The first objective of this investigation is to determine the thermal conductivity of traditional building materials obtained by mixing two kinds of soil (agricultural and soil taken from a type of desert landscape (Hamada)), separately, with different amounts of straw, according to the expertise of the inhabitants of M'Sila (a province of Algeria). The second purpose is to find out the best mass proportion (soil/straw) which gives the lowest thermal conductivity of the obtained earthen materials.

2. Experimental - Two types of soil from an agricultural region and a desert landscape near M'Sila province were used. Straw was added in different amounts to both soils. The ratio between the mass of the soil and that of the straw R is the criterion adopted for this investigation to study the effect of adding straw on the thermal conductivity of the adobe materials formed. Five samples were studied for each soil type, namely R = 20, R = 40, R = 50 and R = 60, in addition the reference one (without straw). The tested samples were obtained by sun drying of the manageable dough formed by soil, straw, and water. The hot wire method is the technique used to determine the thermal conductivity of the samples studied in longitudinal and transverse directions.

3. Results and Discussion - All the tested samples display a thermal anisotropy as the thermal conductivity measured in the longitudinal direction is significantly different from that measured in the transverse direction ($p < 0.05$). The thermal conductivity of the tested samples is strongly affected by the quantity of the straw added ($p<0.05$). It was observed that adding the straw mass equivalent to onetwentieth of the mass of both soils (5% by mass) gives to the Adobe formed a minimum thermal conductivity.
The adobe formed based on Hamada soil presents lower conductivity than that based on agricultural soil.

4. Conclusions - The thermal conductivity is an important characteristic for building material that shows its ability to conduct heat. The earthen materials tested with and without straw verify the thermal conditions of building materials ([0.1, 2] W/m°C).
The thermal conductivity of the studied materials depends on their constituents (nature of soil and voids caused by the straw).

5. References

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